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硕 士 学 位 论 文

# 台湾海峡泉州幅表层沉积物粒度特征及其指示意义

# Surface Sediment Grain-Size Characteristic and Its Indicative Significance on Quanzhou Sea Area in the Taiwan Strait

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# 摘 要


沉积物粒度是沉积地质学中一项重要的动力指标，不同物质来源和沉积环境具有不同的沉积物粒度参数特征及其组合。本文通过分析台湾海峡泉州幅609个表层沉积物类型、粒度含量及粒度参数分布特征，利用粒度数据提取粒级组分信息，其中包括EMMA法、Weibull密度函数拟合法及粒度-标准方差法的运用与对比，并运用粒度趋势分析方法对泉州幅沉积物净运移趋势进行分析，结合浙闽沿岸流、台湾暖流、台湾岛西岸及闽东河流物质的输入背景，反演台湾海峡泉州幅的沉积环境，同时区分不同海域主要物质来源。

研究发现泉州幅表层沉积物主要为粉砂质砂、砂、砂质粉砂，其次为粉砂、含砾砂、砾质泥质砂，零星分布含砾泥质砂、砾质砂、泥质砂、砾质泥和泥。泥、砾质泥、粉砂分布于泉州近岸，远离岸线方向依次分布着砂质粉砂、粉砂质砂、砂。与沉积物类型和水深分布相对应，泉州幅黏土和粉砂含量较高的水域多为水动力较弱、物源较复杂的泉州幅沿岸或近岸，东侧有零星分布；砂和砾含量较高的水域多为水动力较强的远岸及中部水域。

泉州幅表层沉积物平均粒径为0.42~7.48Φ，平均3.70Φ；分选系数为0.37~3.46，平均1.68，分选为好到很差，泉州幅大部分水域分选为差到很差；偏度为-0.68~4.21，平均1.54，偏度为负偏到极正偏；峰态值最小为2.03，最大为27.00，平均6.56，峰态为宽到很窄。总体来说，泉州幅表层沉积物平行岸线的近岸水域平均粒径相对较细，分选性相对较差，偏度为负偏和近对称，峰态为宽或近正态，说明物源较复杂，水动力相对较弱；而平行岸线稍远岸、远岸水域则更多表现为平径粒径较粗，分选性相对近岸好一些，偏度大部分为正偏或极正偏，峰态大部分为窄或很窄，说明物源相对单一，水动力相对较强。

EMMA方法分离的沉积物粒度组分为：EM1（峰值0.76Φ，粗砂级）、EM2（峰值3.55Φ，极细砂级）、EM3（峰值1.76Φ，中砂级）EM4（峰值2.76Φ，细砂级）和EM5（峰值6.54Φ，中粉砂级）；端元组分对沉积区样品总贡献率分别为：EM1≈4.16% ，EM2≈23.27%，EM3≈21.06%，EM4≈35.15%，EM5≈16.36%。且每个站位贡献率≥40%的端元组分分布基本与沉积物类型或粒级含量分布相对应，总

体分离效果较理想。EMMA更加侧重考虑整个沉积区主要端元组分，而对单一样品的反演拟合效果明显比Weibull密度函数法的要来得差，Weibull密度函数法更加适合于需要精确地拟合的有代表性的少数沉积样或柱样的分析。粒度-标准偏差法提取的泉州幅最为敏感的粒级组分为21.38~295.12μm（对应EMMA中的EM4与EM2），说明泉州幅中部与东侧海域的沉积环境与沉积动力在平面分布上较为多变。

浙闽沿岸流携带粉砂、砂质粉砂经平潭岛附近从泉州幅北侧流入；南侧有由西南向东北的净运输趋势，受全年北上的台湾暖流的影响，携带台湾浅滩及澎湖列岛附近的粗粒沉积物；泉州幅西侧有西南向东北的沉积净运输趋势，九龙江口-厦门海湾及小金门岛附近的黏土质粉砂和砾-粗砂物质有可能输入；东侧有东南向西北或由东向西的沉积物净输运趋势，台湾岛西岸的细砂和黏土质粉砂可经沿台湾岛西岸向北流的台湾暖流携带输入；东北端由北向南的净运输沉积物可能包含台湾岛西北岸及东海南部沉积物（砂质粉砂和粉砂质砂），由向南的黑潮水与远岸的浙闽沿岸流携带；泉州幅中部有较大的沉积物净运输集聚区，可见物源与水动力都较为复杂，水动力较强，物质来源于四面八方，最终留下的沉积物主要为砂和粉砂质砂。

**关键词：**沉积环境；粒度特征；粒级组分分离；沉积趋势分析；台湾海峡

# Abstract

Sediment grain size is one of the important dynamic criterions, different sedimentary environments and provenances result in different sediment grain-size parameters. The paper studies the types, gain-size compositions and distribution characteristics of grain size of the 609 Quanzhou sea area surface sediments in Taiwan Strait. We achieve the unmixing grain-size infomations by methods of EMMA, Weibull function fitting and grain size-standard variance. The transport pathways is derived in a sediment trend analysis. Then we can get the sedimentary environment and provenance informations of Quanzhou sea area, combining with the cases of the Fujian-Zhejiang coastal current, Taiwan warm current and the river sediment transports in the western Taiwan and the estern Fujian coast.

The study discovers that the main sediments are silty sand, sand and sandy silt, followed by silt, gravel sand, gravelly muddy sand. The mud, silt and gravel sand mainly distribute by the coast of Quanzhou, far away from the coast are sandy silt, silty sand, sand. Near shore ,high clay and silt components distribute in weak hydrodynamic force water areas, and the semdiment transports are complex. Far away from the shore or in the middle of the area are high sand and gravel components, and the hydrodynamic force is strong.

The mean grain size of study area sediments varies from 0.42 to 7.48Φ, and 3.70Φ on average. The standard deviation is 0.37~3.46, an average of 1.68, the sorting is from well to very poor. The skewness is -0.68~4.21, an average of 1.54, the skewness is from coarse skewed to very fine skewed. The kurtosis varies from 2.03 to 27.00, an average of 6.56, the kurtosis is from platykurtic to very leptokurtic. Overall, nearshore along the coast, relatively, the sediment grain size is finer and the sorting is worse, the skewness is coarse skewed or symmetrical and the kurtosis is platykurtic or mesokurtic, which means complex sediment

provenance and weaker hydrodynamic force. While far away from the nearshore, the sediment grain size is coarser and the sorting is better, the skewness is fine skewed or very fine skewed and the kurtosis is leptokurtic or very leptokurtic, which means more simple sediment provenance and stronger hydrodynamic force realatively.

The EMMA method unmixs the polymodal sediment grain-size distributions into their unimodal end member compositions, and the grain-size unmixing result comes out as EM1(peak value is 0.76Φ, coarse sand), EM2(peak value is 3.55Φ, very fine sand), EM3(peak value is 1.76Φ, medium sand), EM4(peak value is 2.76Φ, fine sand), EM5(peak value is 6.54Φ, medium silt). Their percentages of contributions to the area sediments are respectively about 4.16%, 23.27%, 21.06%, 35.15%, 16.36%. The main end member composition distributions are correspond to the grain-size percentage composition distributions. The unmixing result is good on the whole. The EMMA is suitable for solving many samples once, while, Weibull function fitting method is more appropriate for single or a few typical surface sediments and sediment cores, for its accurate processing is against single sample. The grain size-standard variance method extracts the most sensitive grain size composition value in the sea area is 21.38~295.12μm (corresponding to EM4 and EM2), which reveals that the sedimentary environment and hydrodynamic force is varied.

Fujian-Zhejiang coastal current carries silt and sandy silt from north downward to Quanzhou sea area by Pingtan island. There are SW-NE net sediment transport trends in the southern side of the area, Taiwan warm current carries coarse sediments from the Taiwan bank and the Penghu islands neighbourhood to Quanzhou sea area all the year round. The SW-NE net sediment transport trends also exist in the west of the area, and sediments such as clay silt and gravel-coarse sand may come from sea area of Jiulongjiang estuary, Xiamen bay and Jingmen island neighbourhood. There are SE-NW or E-W ward net sediment

transport trends in the east of the sea area, and the fine sand, clay silt may be carried from western coast of Taiwan to the area by Taiwan warm current. The north-to-south transport sediments in the northeast of the area may include the sediments from northwestern coast of Taiwan and the East China sea (such as sandy silt and silty sand), which can be carried by Kuroshio water and Fujian-Zhejiang coastal current. In the central Quanzhou sea area, there are several large net sediment transport convergence areas, which explaining the sediment sources and hydrodynamic force is complex. The sediments from all directions and the hydrodynamic force is strong, as a result, the remaining main sediments are sand and silty sand.

Keywords: sedimentary environments; grain size characteristics; grain-size composition unmixing; sediment transport trend analysis; Taiwan Strait

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